

Robot-Assisted Thyroidectomy Versus Open Thyroidectomy in the Treatment of Well Differentiated Thyroid Carcinoma

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ABSTRACT

Background: The incidence of thyroid cancer has increased worldwide during the last decade, becoming the most common endocrine malignancy and accounting for 3.8% of new cancer diagnosis. Surgical resection, namely conventional thyroidectomy, remains at the front-line of therapy, as surgical outcomes are undoubtedly successful. Minimally invasive techniques gained popularity through the years, in terms of feasibility, safety, and cosmesis. However, endoscopic approach could be characterized by some limitations concerning thyroid surgery. Robotic technology with its unique features was introduced to overcome these limitations. Since then, robotic thyroidectomy has been used for both benign and malignant thyroid disease.

Database: This study presents the use of robot-assisted transaxillary thyroidectomy in well-differentiated thyroid carcinoma through an extensive review of the literature in the PubMed database, including previous meta-analyses and case series.

Conclusion: In terms of oncological efficacy, morbidity, and quality of life, outcomes seem comparable in thyroid cancer patients undergoing either open or robotic thyroidectomy. Surgical completeness also appears similar.

Moreover, the rates of locoregional recurrence and survival outcome at 5 years are similar between the former and the latter, thus confirming the oncological value of robotic thyroidectomy for differentiated thyroid cancer. In order for more surgeons to adopt robotic approaches several issues need to be resolved, namely: expansion of robotic thyroidectomy in treating larger well-differentiated carcinomas and neck dissection, equipment costs, and prolonged operation times.

Key Words: Robot-assisted transaxillary thyroidectomy (RATT), Thyroid carcinoma, Minimally invasive, Endoscopic thyroidectomy.

INTRODUCTION

Theodore Kocher is unequivocally considered a surgery pioneer in the 19th century; his surgical approach for thyroidectomy, the transcervical incision, was groundbreaking. It remained unmodified from its inception until the late 1990s, when the need for a more minimally invasive technique arose, and an endoscopic approach was described.¹⁻³ Subsequently, in 2000, the da Vinci surgical robot (Intuitive Surgical, Inc, Sunnyvale, California) was approved by the US Food and Drug Administration for certain laparoscopic surgical procedures.⁴ In 2009, Kang et al⁵ published their first 100 case series of robotic thyroidectomy (RT) using the da Vinci Robot System. Since then, many successful experiences using this new technology have been published by several leading groups.

Concurrently, the incidence of thyroid cancer has increased worldwide during the last decade, becoming the most common endocrine malignancy and accounting for 3.8% of new cancer diagnoses.^{6,7} Surgical resection, namely conventional thyroidectomy, remains the frontline therapy, as surgical outcomes are undoubtedly successful. Moreover, there are some limitations to using an endoscopic approach in thyroid surgery. For this reason, robotic technology with its

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unique features, including a dual-channel stereoscopic endoscope offering simultaneous image magnification and depth perception through 3-dimensional visualization; combined with hand-tremor stabilization and the fine control of robotic arms possessing degrees of freedom, substantially enhancing surgical dexterity, was introduced to overcome the limitations of endoscopic surgery.⁸ Since then, this technique has been used for both benign and malignant thyroid diseases. The size limit is commonly set at > 20 – 40 mm for low-risk differentiated thyroid carcinoma, and > 50 mm for benign or indeterminate nodules.⁹ Currently, RT using a transaxillary approach has gained popularity and has been performed in many institutions. However, some surgeons still show reservations about it compared with traditional open thyroidectomy, given that the latter has already generated excellent results.¹⁰

Regarding feasibility, safety, and cosmesis, there is level 2a evidence supporting RT as a feasible and safe approach, and cosmetically superior to open surgery.¹¹⁻¹³ Nevertheless, in assessing a new surgical technique for patients with thyroid cancer, oncologic safety and outcome are the most significant factors, while also considering technical safety, functional and cosmetic outcomes, and surgical completeness. Hence, the major factors for oncological safety and outcome should not be overlooked or neglected in favor of cosmetic or functional outcomes.

STUDY SELECTION

This study presents the use of robot-assisted transaxillary thyroidectomy in well-differentiated thyroid carcinomas through an extensive literature review in the PubMed database during the last decade. Clinical studies, randomized controlled trials, nonrandomized prospective studies (e.g. case-series), retrospective clinical studies, and reviews comparing the efficacy and surgical safety of robot-assisted transaxillary thyroidectomy versus open thyroidectomy in the treatment of well-differentiated thyroid carcinoma were included.

Papers published in languages other than English and published abstracts without full text were excluded. Editorials, letters to the editor, and case reports were also excluded. Since the aim of this review was to study the efficacy and the oncological completeness of thyroidectomy for well-differentiated thyroid carcinoma, studies comparing the efficacy of these two procedures in the treatment of nonmalignant thyroid pathologies were not included.

DISCUSSION

Robot-assisted transaxillary thyroidectomy (RATT) has become a widely used treatment modality for thyroid disease, mainly in the far East; therefore, most of the data, in particular for thyroid carcinoma, have been extracted from there, since the procedure remains under discussion in the Western world.¹⁴ Surgical outcomes could be assessed by comparing multiple parameters, such as operation time, blood loss and total drain amount, length of hospital stay, metastatic and retrieved lymph node, as well as postoperative thyroglobulin level, pain score, and cosmetic satisfaction. Adverse events and complications, such as hypoparathyroidism and recurrent laryngeal nerve palsy, are at the frontline of RATT evaluation for thyroid carcinoma. Recurrence rate and surgical completeness are two additional factors that should be evaluated in the comparison of traditional open thyroidectomy and RATT.

Operative time is significantly longer in RT than open thyroidectomy.^{8,12,15} The preparation of the working space, robotic docking, and surgeon's experience are the main reasons contributing to longer operative time.¹⁶ Sun et al¹⁷ in their meta-analysis demonstrate that mean operative time of RT exceeded conventional open thyroidectomy by 76.7 minutes, whereas, there was an increased mean difference of 48.1 minutes via robotic approaches, specifically in total thyroidectomy patients and 37.3 minutes via robotic approaches in subtotal thyroidectomy patients. Nevertheless, it tends to decrease with the accumulation of experience and arrives at a steady state after 35 to 40 cases. This number is considerably lower, compared to the learning curve of the endoscopic transaxillary procedure (55 to 60 cases), since there is debate between minimally invasive and traditional approaches on thyroidectomy.¹⁸

With regard to blood loss and total drain amount, Son et al¹⁸ conclude that RT is associated with lesser blood loss, seroma, or hematoma formation than with open procedure.¹⁸ However, Pan et al¹⁹ were the first to report more total drain amount postoperatively in robotic than in open thyroidectomy. Nevertheless, it must be noted that the heterogeneity was high. An appropriate reason for this result is the wider dissection area, including anterior chest wall, in order to reach the thyroid gland. However, intraoperative blood loss was comparable between the former and the latter.¹⁹

As far as hospital stay is concerned, review of the literature shows that there is no significant difference between the two

methods.^{20–22} This was confirmed by both Son et al in 2014 and Pan et al in 2017 in their meta-analyses, in which 7 and 17 studies were pooled, respectively. Although patients who underwent RT had a shorter length of hospital stay compared to open thyroidectomy, the difference was nonsignificant.^{8,19}

With regard to metastatic and retrieved lymph nodes, an issue which is at the frontline of oncologic surgical outcome, robotic approach does not lack superiority over open or even endoscopic thyroidectomy. Although a meta-analysis by Son et al¹⁸ of 7 studies reported a greater number of retrieved lymph nodes in open thyroidectomy compared to robotic, there was no significant difference in sensitivity analysis.¹⁸

Postoperative serum thyroglobulin level is also an important factor that substantiates oncological efficacy of thyroidectomy. Results emphasize that RT is comparable to open procedure.^{23,24} Pain score and cosmesis satisfaction are two additional factors that need to be measured in order to have a more detailed surgical outcome; nevertheless, they do not play a pivotal role with regard to thyroid cancer operations. Most of the studies and meta-analyses using an analog pain scale, as it has been already applied for the comparison of minimally invasive procedures to open ones, showed no significant statistical differences for postoperative pain in the first 24 hours.²⁵ However, cosmetic satisfaction rate was significantly higher for patients who underwent RT, in a time period from 3 to 6 months follow-up after surgery.²⁶ Moreover, swallowing impairments also play a role on both patients' and surgeons' minds about the overall surgical outcome. Review of the literature shows quite discordant results,⁸ as in one study patients who underwent open thyroidectomy had worse postoperative scores in contrast to RT patients,²⁷ and in another study there was no significant difference between open and RT in the self-evaluation of swallowing difficulty.^{8,20}

With regard to adverse events and complications, surgical considerations are targeted mainly to hypocalcemia and recurrent laryngeal nerve palsy, either transient or permanent. Besides hemorrhage, hematoma, and seroma formation, chyle leakage and injuries also need to be studied. Tae et al²⁸ mentioned in their study a significant difference of transient hypoparathyroidism between open and RT with favor of the former. In contrast, seroma formation was significantly higher on the group of patients who underwent RT. Difference between postoperative hematoma formation or severe hemorrhage that needs re-exploration was not statistically significant, whereas, re-operation was achieved from the pre-existing incision in both cases. Percentages of recurrent laryngeal nerve injuries were

3.8% and 1.6% for open and robotic surgeries, respectively.²⁸ Unfortunately, one case of permanent nerve injury was described, but not after robotic approach. Lang et al¹⁵ reported in their systematic review and meta-analysis a significant greater risk of recurrent laryngeal nerve injury in robotic approach. However, the aforementioned rate was higher only for temporary and not for permanent nerve injuries. The reason for the higher temporary nerve injury in RT could not be explained adequately, but since higher permanent nerve injury was not detected, it may have been caused by mild traction injury.

Adverse events such as tracheal or brachial plexus injuries were not described routinely. Nevertheless, in some case series brachial plexus injuries or discomfort on shoulder movement were described^{29,30} undoubtedly, these are unique complications which arise from robotic implementation. Apart from Kim et al's experience of 5,000 transaxillary robotic thyroidectomies,⁶ several meta-analyses come to the same conclusions as well. Kim et al describe complications that were exclusive to robotic thyroidectomies; axillary skin flap perforation in 8 patients (00.2%) and transient brachial nerve paralysis in 4 patients (00.1%). Transient paralysis of the brachial plexus occurred due to the hyperextension of the arm and all patients recovered spontaneously within the second postoperative month. Sun et al⁸ evaluated a brachial plexus injury rate of 2.2%, of patients who underwent robotic thyroidectomy, presented either with discomfort on shoulder movement, or with decreased range of motion, difficulty gripping, and handwriting. Symptoms were conservatively resolved up to 3 months postoperatively. With regard to tracheal injury, Materazzi et al¹⁴ reported only 1 in a series of 250 cases of robotic thyroidectomies. Tracheal injury resulted in a leak which occurred on the first postoperative month and was successfully treated conservatively.

The aforementioned unique complications of robotic thyroidectomy need not to be overlooked. Brachial plexus injuries could be avoided by placing the patient's arm in a flexed position and avoid more than 90° of extension on the elbow and shoulder joints. Besides, intra-operative axillary neuromonitoring could be useful in reducing the chance of brachial nerve injury. Last, but not least, it is of great importance to take into consideration the risk, although extremely low, of seeding tumor cells along the incision during the extraction of the gland. To this effect, most surgeons suggest routine use of an endobag in order to remove the thyroid gland.

Surgical completeness and recurrence rate are of fundamental value to accredit efficacy for the surgical approach used.

Radioactive ablation iodine uptake rate, thyroglobulin levels and neck ultrasonography are the major parameters to substantiate resection completeness. Review of the literature emphasized no significant differences between open and robotic surgeries.^{19,24} Nevertheless, it is noteworthy that in the unilateral approach of RATT, complete resection of the contralateral lobe is characterized by greater difficulty, mainly in cases where a deeply seated Berry ligament or a prominent Zuckerkandl's tubercle is present.³¹ This could affect thyroid remnant and since the approach is for well differentiated carcinoma, amount of thyroid remnant is of great importance. Regarding recurrence, it is associated not only with the thyroid remnant but with metastasis of the lymph nodes as well; neck dissection, either prophylactic or therapeutic, plays a pivotal role under certain types and cases of a thyroid carcinoma. To this effect the number of retrieved nodes needs to be evaluated. With respect to the aforementioned data on metastatic and retrieved lymph nodes, inter alia, a prospective comparison by Lee et al in 2014,³¹ conclude that the number of dissected nodes with transaxillary robotic approach was comparable with that of open thyroidectomy,³¹⁻³⁷ thus fulfilling the criteria of oncological efficacy.

CONCLUSION

The aforementioned results from meta-analyses and case series show that RATT is a safe and feasible therapy for the treatment of well-differentiated thyroid carcinoma, when performed by surgeons who are familiar with and experienced in endoscopic and robotic techniques. RATT is associated with a better cosmetic satisfaction and a lower level of swallowing impairment as has been confirmed by the application of robotic thyroidectomies for benign diseases of the thyroid. Furthermore, since the first implementation of RATT for thyroid carcinomas it has now been established that it is comparable with open thyroidectomy in terms of outcomes, adverse events and complications, surgical completeness, and recurrence rate. Nevertheless, robust results regarding oncologic outcomes could be extracted after a long-term follow-up, exceeding 20 years, as two-thirds of recurrence occur during the first 5 years.³⁸ Besides, it must be noted that RATT has also introduced unique complications that should not be overlooked.

Expansion of RATT into the therapy of large-sized, well-differentiated carcinomas neck dissection, while reducing the equipment costs and prolonged operation times, are issues that need to be addressed so that robotic approaches can be adopted by more surgeons not only in the far East but in the Western world as well.^{39,40}

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